of an independent investigator. Had his work 'On the Relative Atomic Weights of Nitrogen and Sulphur' been presented in Leipzig, I should gladly have accepted it, not only as a doctor's dissertation, but also as a sufficient qualification for the position of university lecturer (Privatdozent).

"(*Signed*) Wilhelm Ostwald."

Prof. Th. W. Richards wrote:—

"The investigations of Mr. F. P. Burt seem to me to present many points of interest, and to indicate a high order of experimental ability. In view of the fact that a large proportion of the work was done by Mr. Burt himself, even when he was assisted by collaborators, the sum total of his papers appears to me to present more than the equivalent of a thesis for the doctor's degree in the best universities in America. It must be remembered, however, that a thesis is only a part of our requirement.

"(*Signed*) Theo. W. Richards."

Copies of these letters were sent to the Senate of the University of London in July, 1911, together with a letter, the last sentence of which is:—"Since it appears to me (and my opinion is shared by Profs. Dixon and Collie) that an error of judgment has been made in Mr. Burt's case, we would respectfully urge you to reconsider his claims."

On October 18, 1911, the Senate passed the following resolution:—

"That, having considered the communication from Sir William Ramsay of July 10, 1911, and having heard a report from the examiners, the Senate are not prepared to vary the decision at which they have arrived."

As it was impossible to believe that the Senate attached more importance to the decision of their examiners on the merits of the thesis than to the verdict of special experts, the inference was obvious that they considered that the work, or a sufficient proportion of it, had not been done by the candidate. Perhaps this view was partly justified by the terms in which Mr. Burt had thanked all those to whom he supposed himself indebted during the progress of his research; his expressions were, to say the least, generous.

The Regulation for External Students (Blue Book, Univ. of Lond. Calendar, p. 294) is:—"If the Dissertation or Thesis be approved by the Examiners, the Candidate shall be required to present himself . . . to be further tested either orally or practically, or by printed papers, or by all these methods. . . ." But in certain circumstances the candidate may be exempted.

It was therefore within the powers of the examiners to have interviewed the candidate, to have asked him the nature of the assistance which he acknowledged, and to have obtained from him the names of the persons assisting him, and, should his word have been doubted, to have written to them inquiring as to the extent and nature of the help given. This was not done. Hence it appeared necessary to obtain from all those who knew of Mr. Burt's research testimony as to the share they had had in it. Prof. Travers, Prof. Usher, Prof. Francis, and Dr. Whytlaw Gray all testified most emphatically that the share which they had borne in the work was insignificant, and that the work was in every sense of the word original. Prof. Dixon, in whose laboratory Mr. Burt is now assistant, although not having been in contact with Mr. Burt during the progress of his thesis research, voluntarily wrote to me expressing the opinion that work in which Mr. Burt is at present engaged is being done "in a masterly manner," and that he has "no doubt as to the capacity, manipulative skill, foresight, and patience which Burt possesses to carry out such work."

Copies of these letters were sent to the Senate on November 27, 1911, and they were again requested to reconsider their decision not to admit Mr. Burt "to be further tested." On January 25, 1912, the Senate resolved:—"That the Senate decline to reopen the question of the rejection of the D.Sc. candidate referred to."

After this final refusal no course remains but to make public the facts of the case. And this I do, not so much in justice to Mr. Burt, but in order to raise the much larger question as to whether it is proper that a system in which such injustice can be perpetrated should continue to exist. I am led to understand that complaints are not infrequent that candidates of undoubted merit, not only in the faculty of science, but in other faculties, have had their theses rejected without sufficient reason. There is one instance, at least, of a thesis which, after summary rejection, was subsequently published in book form, and which received the highest encomiums from the Press and from private persons of eminence in the subject treated. On the "internal" side of the University I am unaware of any complaint having been made, for much more care is bestowed; and besides, the teachers, who are also examiners, are acquainted with the candidates' abilities from frequent personal communication, and often from daily contact.

There can be no doubt that such miscarriages of justice are to be attributed, at least in part, to the growth of the University. With few candidates some sort of acquaintance on the part of the examiners with their merits is possible, but with increase of numbers control becomes impossible. Moreover, there is a growing reluctance on the part of men of established reputation to accept the post of examiners; the work is hurried, it is badly paid, and it is a thankless task. The fact is that the day of "external" examinations is past; the system is an anachronism; and I think that the case which has been presented furnishes an irrefutable argument why that system should be abandoned. A degree is in essence a testimonial; and a testimonial from a corporate body depends for its value on the eminence of the persons capable of forming a judgment on the merits of the graduate and on their opportunities for forming a correct judgment. Where the examiners are not eminent, and where the opportunity of forming a judgment has not been given or has not been taken, the degree is worthless, and the corporate body awarding it should cease to exist.

W. Ramsay.

University College, Gower Street, London, W.C.

Are Eyes ever Autophanous?

Those who read Colonel Herschel's letter in Nature of January 18 may be interested in some observations which I made during the summer upon the sight and eyes of cats. Whereas in men and monkeys the retina is backed by black pigment, as a photographer backs a plate when his camera is to be directed towards a window, in almost all other mammals it rests on a brightly burnished layer of cellular or fibrous tissue, the tapetum. It is this mirror which throws the light back to an observer who stands between the animal and the source of light. The eye is at the same time a camera focussed to form an image of the observer on its sensitive screen and a lantern focussed to project light upon the observer. Such an arrangement appears to a photographer fatal to the formation of an image sharp in line and dot.

Many explanations of the function of the tapetum have been offered, but none, to my thinking, satisfactory. To me it has long seemed that its only purpose can be to render the eye sensitive to movement, as distinguished from form. I studied my cats as they hunted field-mice. One of them would crouch for hours in front of a hedge. Seated at a moderate distance, I was able on several occasions to see the catch, a single spring in the direction of the mouse, whether it moved at the spot at which the cat appeared to be staring or considerably to one side or the other of the axis of her head. For movement her vision was perfect. If, as she roamed about the lawn, a daddy-longlegs shook a blade of grass, she sprang towards it. But to stationary objects she paid scant attention. In various places I fixed a dead mouse in as natural an attitude as I could make it assume with the aid of wires and wooden pegs. If the cat passed close to it she would stop to smell it, perhaps to pat it, but she never showed any sign of regarding it as something to be caught. In hunting for birds, on the other hand, her whole method was reversed. Cautiously climbing, she would study a dead leaf with the utmost care, afraid to move lest she should disturb a possible victim.

It seemed to me that the upper and lower halves of the retina functioned in different ways. I therefore examined the eyes of several cats. When perfectly fresh, the interior of the eyeball, seen under a dissecting microscope, is one of the most marvellously beautiful obects that can be conceived. The opalescent retina rests on a silver mirror

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mottled with gold. The surface of the mirror is raised in low ridges, which radiate outwards from the centre in waving lines, like the sun's rays on the Japanese flag. After a few minutes' exposure to air or water a film of metallic green and blue invades the silver. But the tapetum does not line the whole of the back of the eye. It is bounded by a sharp irregular line which crosses the wall of the globe horizontally, about ·1 mm. below the level of its equator. The lower portion of the retina, a little less than a quarter sphere, is backed, as it is everywhere in the human eye, by dense black pigment. Colonel Herschel observes that a man's eye does not gleam.

In a superbly illustrated monograph published in the Philosophical Transactions of the Royal Society Dr. Lindsay Johnson pictured the eyes of a great number of the animals in the Zoological Gardens as he saw them with an ophthalmoscope. With the exception of monkeys, the elephant, rhinoceros, and hyrax, all terrestrial mammals are provided with a tapetum. The exceptions are significant. In monkeys, as in ourselves, the retina shows a "yellow spot." They trust to direct vision with its minute discrimination of detail. They move their eyes with great rapidity towards the objects which they wish to examine. Such rapid movement is incompatible with extreme sensitiveness to the movements of external objects. A cat does not move its eyes. It moves its head. Of hyrax I have nothing to say, but the elephant and the rhinoceros stand alone amongst Herbivora. They alone are indifferent to the movements of lurking enemies—great cats and snakes. They do not need to sacrifice visual precision, as it must be sacrificed in animals in which the retina is backed by a mirror, in favour of a capacity of detecting movement.

I have examined the eyes of a considerable number of animals, and find that the disposition of the tapetum, considered in its relation to the habits of the animal, is in all cases in harmony with the view as to its purpose which I have here expressed. I am also prepared to give an explanation of the optics of its relation to the retina, but for this or for special illustrations I must not trespass upon your space. ALEX HILL.

COLONEL HERSCHEL's letter in NATURE of January 18, followed by that of Mr. Hunt, have no doubt interested others besides myself. I do not think that there is any reason to suppose that any animal's eyes are "autophanous," however general the belief to the contrary may be among those not given to accurate observation. I can add to the list of the apparently autophanous the springhaas in South Africa and the common English mouse. I generally encourage a few of the latter, and at the present time three have taken up their abode with me in Victoria Street. There is a regulator clock standing $1\frac{5}{8}$ inches away from the wall, and about 6 feet high. I put a little food on the top of the clock, and sometimes behind the clock not quite so high, and in other awkward places. The mice jump on to the skirting board, and there spread themselves out sideways so as to stretch the $1\frac{5}{8}$ inches, and then proceed to go up at an angle of about 40°, climbing, so to speak, a staircase that is not there, and then when this brings them to the side of the clock they turn over in a nimble way with a jump, not always successfully, and negotiate the next flight, and so zigzag to the goal. I often watch these quite close, holding a metallic filament electric light with shade, so that they are fully illuminated and I am in shade. So long as I am quiet or move slowly, doing nothing spasmodically, they take no notice. I have even prodded and moved the food they were eating with the slide of a long rule, which seemed to perplex rather than frighten them. They do not seem to hear loud noises or singing provided they do not contain S, K, or other sudden sounds, even though I am not a yard away. A few days ago while writing I heard one at work on some bread about 4 feet from the ground, when, to see him better without getting up, I focussed the filaments of the electric lamp upon him with a large reading-glass. The mouse did not seem in the least frightened, but stared at the lens a short time, and then I saw his eyes shining with a pale ruby, or rather spinel, colour, and was reminded of Colonel Herschel's letter.

The same action which makes animals' eyes appear "autophanous" is seen in far greater perfection in that invaluable little instrument called the reflex light, now used in large numbers to protect the bicyclist from being run down by a motor-car at night. The bicyclist's lamp, of course, is useless, as its light in the road is outshone by that of the motor-lamps, and the lamp itself is generally not directly visible from behind. The bicycle and rider, too, are often by no means conspicuous objects, and the danger of being run down is a real one. To meet this, the reflex light has been invented. It may be considered to be a glorified cat's eye. All that is visible from the outside is a ruby bull's-eye lens, but inside, in the principal focus of this lens, there is placed a concave silvered reflector of half the focal length, *i.e.* the bull's-eye is at its centre of curvature. Any strong light shining upon the bull's eye is therefore brought to a focus on the surface of the mirror, and whether the light is directly in front of the lens, or on one side even to a surprising degree, the focussed light falls normally upon a portion of the reflector, which sends it back to the lens, and so in a parallel beam in the direction from which it came. The driver of the car and his lamps subtend so small an angle at a distance of, say, 200 yards, or very much less, that the reflected light is seen by the driver like a red lamp. The committee of the Associated Automobile Clubs were so impressed with the value of this device that the technical committee of the Royal Automobile Club, of which I am a member, examined and tested the reflex light, and they issued a certificate endorsing the claims made for it. There is a feeling that every cart in the country should carry one, which, unlike ordinary lamps, would entail no trouble or running expense, and would be free from all risk of fire. This reflex light beats any cat's eye or other animal's eye, but it is not autophanous.

C. V. BOYS.

THE experiments described by Colonel Herschel in NATURE of January 18 illustrate the reflecting power of animals' eyes, and give no support to the general view that the eyes of cats and dogs "shine in the dark," that is, in the absence of any external source of luminosity. The principle of the experiments is illustrated by the Reflex Lamp commonly fixed at the back of the frame of a bicycle in rural districts. This is not really a lamp, but a bull's-eye of ruby glass about 2 inches in diameter, fixed with the convex surface directed behind the bicycle. When a carriage or motor is approaching the bicycle from behind, its lamps illuminate the bull's-eye, and the reflection is so clear that the driver knows a cyclist is in front of him long before the rider or the machine can be seen. The candle-light used in ordinary carriage lamps enables the Reflex Lamp to be visible at a distance of a hundred yards or so on a dark night. The conditions are precisely similar to those described by Colonel Herschel, the only difference being that a glass convex lens takes the place of the animals' eyes. R. A. G.

January 27.

Glazed Frost; a Reminiscence.

MR. HARDING's letter (NATURE, January 25, p. 414) reminds me of an experience which, in view of the rarity of the phenomenon, may be of sufficient interest to place upon record in these columns, although the newspapers of the period—the sixties of last century—duly noted the occurrence. It must, I think, have been in 1866 or 1867 (date and year uncertain) that I had occasion to go from the West to the East End of London. Starting upon my journey about 10 p.m., it began to rain soon after I left the house in Bayswater, and I opened an umbrella, which, to my surprise, became stiffer and heavier every moment, and was found on examination to be so thickly glazed over with ice that it was impossible to close it. At the same time the pavements and roadway were also becoming uniformly glazed; pedestrian movement was most difficult, and all horse traffic was suspended. Although an experience of some forty-five years ago, the impression left upon my memory is still vivid—the ludicrous sight of people carrying ponderous and rigidly frozen umbrellas which they could not close, the stream of skaters down Oxford Street

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